# ACTUAL TRACK CAPACITY OF A RAILROAD DIVISION

BY

MOSTAFA KHALIL KAMEL MOSTAFA

B.S., Fouad First University, 1941
M.S., University of Illinois, 1948

## AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN CIVIL ENGINEERING
IN THE GRADUATE COLLEGE OF THE
UNIVERSITY OF ILLINOIS, 1951

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## ACTUAL TRACK CAPACITY OF A RAILROAD DIVISION

The track capacity of a railroad division is the maximum number of trains that can be moved in a specified time.

The problem involves estimating in advance, the maximum number of trains that could be moved under any particular method of train operation.

Since unexpected train delays are an inseperable part of freight train operation, one has to distinguish between the theoretical track capacity where no delays at all are considered, the potential track capacity where the delays set by the rules to insure safe train operation are taken into consideration, and the actual track capacity where all delays, set by rules or unexpected are considered.

The potential track capacity is a theoretical value which cannot be attained under any system of train operation, it represents an ideal condition never realized in railroad operation. Under any system of train operation the potential track capacity can be calculated as shown in chapter 11. of this thesis.

The potential track capacity, however, is an important value to determine since it is used in the calculations to determine the maximum number of trains that can be actually operated on a division.

The actual track capacity takes into consideration all delays that actually occur. The train times for a certain test period are compiled from the Dispatcher's Train Sheets and are arranged according to their magnitude starting from shortest to longest road time. The area under the train-hour diagram thus drawn represents the actual track capacity.

It is shown that the road time of trains may be considered as a chance phenomenon which can be represented by a fre-

quency curve. The train-hour diagram is shown to be a cumulative frequency distribution which can be reasonably fitted with the cumulative curve of Pearson's Type 111 Frequency Curve, by determining the average road time $t_{av}$, the coefficient of skewness $\alpha_3$, and the standard deviation $\sigma$ of the road time distribution.

Changing the length of the division, the number of trains or the average overall speed of the trains influences the fitted curve of a certain division and thus makes it possible to determine the actual track capacity for a similarly operated division that may differ in length or speed of trains.

The relation between the numbr of trains and the average road times is found to be:

$$t_{av} = t_o + K N$$

$t_{av}$ = average road time
$t_o$ = minimum road time
N = number of trains
K = interference factor

But, since the maximum possible utilization of the division is represented by the potential track capacity, A (train hours), the maximum number of trains that can actually be operated on any division will be limited by the train that takes the maximum road time to cover the division.

That is:

$$N = A/t_{max}$$

In other words, $A = N \times t_{max}$

where:

N = maximum number of trains to be determined
A = potential track capacity in train hours.
$t_{max}$ = maximum road time to be obtained from fitted curve.

Since the lower limit of the fitted curve is infinity the maxi-

mum road time is considered as that corresponding to 99.9% of the trains.

The maximum number of trains that can be actually operated on a division is found by solving the equation

$$A = (\sigma t + t_0)\ N + K\ N^2$$

where:

A = potential track capacity in train hours
$t_0$ = minimum road time
K = interference factor for the distribution of the test period
t = abstract number obtained from the following table corresponding to the coefficient of skewness of the distribution of the test period.
$\sigma$ = standard deviation of the test period distribution.

| $a_3$ | t | $a_3$ | t |
|---|---|---|---|
| 0 | 3.09 | 0.6 | 3.95 |
| 0.1 | 3.23 | 0.7 | 4.10 |
| 0.2 | 3.37 | 0.8 | 4.24 |
| 0.3 | 3.52 | 0.9 | 4.38 |
| 0.4 | 3.66 | 1.0 | 4.53 |
| 0.5 | 3.81 | 1.1 | 4.67 |

# VITA

Mostafa Khalil Kamel Mostafa was born on January 8, 1920 in MietGhamr, Egypt. After graduation from Saidia High School in Cairo, Egypt in 1936, he enteded Fouad First University of Cairo, Egypt, and received the degree of Bachelor of Science in Civil Engineering in June 1941. He then joined the Egyptian State Railways in June 1941 and held the position of a Zone Engineer in the Cairo Division, until he was appointed to leave for the United States of America in a Fellowship Mission by the Egytian Government to study and have practical training.

Upon arrival in the United States in March 1947, he joined the Chicago, Milwaukee and St. Paul Railroad Co. as a trainee and was placed in Miles City, Mont. until he entered the Graduate College of the University of Illinois in September 1947. He received the degree of Masters of Science in Civil Engineering from the University of Illinois in August 1948. He held a Research Graduate Assistantship from September 1949 to June 1951.

He is a member of the American Railway Engineering Association, the American Concrete Institute and the Egyptian Engineering Association and an Associate Member of the American Society of Civil Engineers and the Highway Research Board. He is a member of the Phi Kappa Epsilon International Honorary Society.

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